Understanding Cause-Effect: Learning through language

By Bernard Mohan and Margaret van Naerssen

Have you ever looked at a sample of a student's writing and could not quite figure out what was wrong with it? Have you ever listened to a student painfully trying to talk about a topic the student knows something about but just does not have the language needed to express it? Sometimes the problem is inadequate language skills, but all too often something else is happening. Maybe the learner has not initially organized his/her ideas. Maybe the learner has only a superficial understanding of the content without understanding the logical relationships of ideas and information. Sometimes it is a combination of factors.

Thinking is hard work, as is learning new knowledge through another language. Organizing ideas, even in your first language, is hard work! It is easier to do when you are talking, writing, or reading about something concrete, but even then it's easy to get a bit disorganized, to ramble off the topic, to get distracted. When you begin moving from concrete to abstract content, the difficulty level goes up even in your first language. Having to do it in a foreign/second language (FL/SL) can be a real mind-bender!

Language is the major medium of learning and teaching in education (Mohan 1986). A significant part of learning about a concept in a subject matter involves collecting information, organizing it a certain way, interacting with the concept, and communicating an understanding of the concept. We often overlook precisely how language helps us in this process and how language and meaning interact.

In this paper we want to illustrate, through the concept of *causality (cause-effect, causal meaning)* how thinking and language are connected.

Part I: Learning Through Language

Education is becoming more international, multilingual, and multicultural. More students are spending more time learning through another language: reading a textbook, newspaper, or a journal in another language, having some or all of their curriculum taught in another language, accessing foreign language material on the Internet, communicating in a foreign/second language with native speakers in other parts of the world, learning about another culture through musical lyrics in a foreign language, and so on.

As this happens, issues related to the role of language as a medium of learning will become increasingly significant. Opportunities to learn that were neglected in first language education, problems that were unrecognized or untreated, all surface in the FL/SL. Usually, however,

problems are seen strictly as a lack of language proficiency. Language teachers are expected to solve these problems in an extra course or two of traditional FL/SL language teaching. And frequently we buy into this claim that it is just a lack of language proficiency. This is a mistake.

We might intuitively sense there is more involved than we can deal with in such a short time. But like learning in a first language situation, in FL/SL language settings, we frequently do not understand precisely how the FL/SL interacts with the learning process in subject matter areas. Neither do others in our educational institutions.

Native language and FL/SL teachers need to be able to cooperate with each other and with subject matter teachers. This includes foreign language teachers cooperating with those who are teaching content through the learner's first language. This cooperation is hard to achieve; thus, this blocks our progress in better understanding how language and learning interact.

Why does this happen? Below are two common but false assumptions teachers and learners make about first language learning which then affect assumptions we then make about FL/SL learning.

General Assumption #1: Language is essentially seen as form rather than as form and meaning. FL/SL Assumption #1: Speaking, listening, reading and writing in the second language thus are seen as simply matters of "applying" this code. General Assumption #2: When students come to school at age 5 or 6, their language development is seen as more or less complete. FL/SL Assumption #2: FL/SL learners are fully developed users of their first language. They need only to learn the second language as a new "code" of items of grammar and vocabulary.

One result of these assumptions is that the role of the foreign/second language teacher is seen as quite separate from the role of the first language teacher and from the role of the content specialist. To understand language as a medium of learning, we need to work from a different set of assumptions.

New Assumption #1: Language is a matter of mean-ing as well as of form. New Assumption #2: Discourse does not just express

meaning. Discourse creates
meaning. New Assumption #3: Our language development continues throughout our lives, particularly our educational lives. New Assumption #4: As we acquire new areas of knowledge, we acquire new areas of language and meaning.

A number of implications follow from this richer understanding of language as a medium of learning. In this paper, however, we will concentrate on the implications for a view of the second language as a medium of learning. To illustrate this more concretely, we have selected CAUSAL PATTERNS of MEANING, in other words, how CAUSE-EFFECT meaning is built with language. We have chosen CAUSAL discourse because it is an important concern of many subject area teachers. As a result, language specialists and subject area specialists might collaborate very productively on this topic.

Adult learners are frequently introduced at the intermediate level to ways causal meaning is expressed, especially for academic situations in reading and writing courses. However, we feel the way it is taught is quite limited.

1. Most textbooks do not provide a very wide range of ways in which causal meaning can be expressed. They provide primarily lists of conjunctions such as "therefore," "because," and phrases such as "as a result of," and perhaps a short list of causative verbs. These are scattered about a textbook.
2. Frequently no preliminary work is done to check to see how the learner is thinking about a topic before starting a writing assignment involving causal meaning. Outlining is done sometimes, but frequently no rigorous feedback is given on the logic of the outline. Graphic organizers are frequently not used, beyond the networks of schema circles.
3. Most importantly, frequently neither *teachers* nor students are asked to *work with* the concept of causal meaning in relation to learning specific content. It is simply assumed that decoding from one language to another is all that is needed. Underlining causal conjunctions in a reading passage is not enough. Reference to model paragraphs containing "cause-effect" statements, provided to assist learners in writing similar passages, does not push the student to interact with the content very much. When teachers actually try out the writing assignments they give their students, they are reminded of how difficult this type of thinking actually is.

With secondary students such causal language, when it is introduced, frequently is introduced independently of cognitive skills and concepts being developed in content courses taught in the learners' first or second language/foreign language. The same concerns given above also apply to these students.

Part II: What is the "Line of Events" or Steps in a Causal Process?

The following section about a traditional Egyptian water cooler, the *zeer*, describes students' interpretation of causal meanings from the text (See Figure 1 below).

After reading the passage about the water cooler, students should be encouraged to:

1. Draw diagrams to show how the *zeer* works as a water cooler.
2. Explain how the *zeer* works as a water cooler.

Below is a five-step explanation of a *causal* process taken from the reading passage about the zeer.

1. Water in the pot is slowly absorbed by the clay.
2. As absorbed water reaches the outer surface of the pot, it evaporates quickly because of the dry air.
3. The evaporating molecules absorb heat from their surroundings.
4. The process of evaporation cools the pot.
5. The pot then cools the water being held by the pot.

Student samples of the causal process
After students studied the reading, they made drawings of the process and then wrote about the process. They could not, however, refer back to the reading passage. Figure 2 contains three students' written versions of that process, followed by a discussion of how they tried to express that process. Students' drawings of that process will also be discussed. Note that ***bold italics*** marks action/event verbs and marks conjunctions and similar devices.

Discussion. The *zeer* discourse shows a "line of events" or "sequence of events," a typical element of *causal meaning* . This is shown in a five-step explanation taken from the passage. Time sequence is a frequent knowledge structure (or pattern) of discourse. It is interesting to note how the students express this sequence of events, how they convey the steps of how the *zeer* works. Each of them does it in a different way from the original, and with varying success. Student A is the clearest, putting the events in a numbered list to express the sequence. Student B links the events with ordering phrases like "first of all" and "after this." With Student C it is not easy to interpret the sequence of events clearly.

A comparison of A's text with C's text suggests where the problems with C's text lie. The reader understands that each numbered line of A's text is a progressive, dynamic step in the total process; each line has an action/event verb in the simple present tense usually with a specific subject. In C's text, on the other hand, the reader's construction of the sequence of events is "interrupted" by "water can be purer" and "water is easy to evaporate." The reader understands these statements as static (unchanging) background information, not as dynamic events, because of the modal "can" and the verb "is." In other words, the way A composes a line of events agrees with the reader's expectations that each dynamic event will have an action/event verb.

Longacre (1989, 1990) shows how, in a similar way, narratives have "storylines," and procedural discourse has a "line of procedure." He explains how dynamic and static elements are marked to construct the storyline in narratives in English, and compares and contrasts narratives in a range of other languages.

The "line of events" is not only expressed in the students' texts. It is also expressed in their small group drawings. For example, A's text compares interestingly with the drawings. In Figure 3 below students divide the process into three events, labeled "Absorbing," "Evaporating," and "Cooling," each with a diagram of the pot. The diagrams are numbered to show the sequence of events, just like A's text. Where A creates an event with a sentence, in the drawing the students do so with a diagram, just as a picture story does.

Several other student drawings (see Figure 4 and Figure 5 as examples) followed this same convention of representing an event with a diagram. However, there is a problem. How can a static diagram show the dynamism of an event? Some of the student drawings solve this problem by the use of arrows. In Figure 3 and Figure 5 for instance, arrows indicate the process of the water being absorbed into the clay side of the pot.
The "line of events" draws attention to meaning. Students can use the "line of events" to compare how they express their ideas in writing and how they express the same ideas through drawings. They can use the "line of events" to concentrate on the central meanings in their writing rather than on minor details of form.

Part III: Are the Steps in the Line Linked by Causal Relations or Time Relations?

So far we have looked at the events in the cooling process as a time sequence, saying that one event comes before the other in time. But this is not the same as saying that one event causes the other.

When are the students writing that one event happens another? And when are they writing that one event happens another?

Student A simply lists the events in sequence, and uses no explicit *causal* language at all (See Figure 2 below).

Student B uses both time sequence language ("First of all," "after this") and *causal* language ("so").

Student C marks time sequence ("When") and cause ("so," "because of"). Interestingly, Student B, marks time sequence for the first two events, whereas Student C marks them in a stronger, more *causal* relationship by using the conditional "if."

It is very important for students to be clear about the difference between time sequence (After A, B happens) and *causal* relation (Because of A, B happens). "After the doctor operated, the patient died" is very different in meaning from "Because the doctor operated, the patient died."

In the two lists (a. and b.) below we show contrasts between time sequence language and causal language and between event language and action language.

a. Linking time sequences or causal relations

	Time sequence	Causal relation
Conjunctions	First, next, then 1 happens. Next 2 happens	Thus, therefore, so 1 happens. Therefore 2 happens
Dependent clause	When 1 happens, 2 happens	Because 1 happens, 2 happens.
Circumstances	After 1, 2 happens	Because of 1, 2 happens

b. Are the steps in the line events or actions?

Events	The water cools. What HAPPENS to the water? It cools. The crop grows. What HAPPENS to the crop? It grows.
Actions	The pot cools the water. What does the pot DO? It cools the water. The farmer grows the crop. What does the farmer DO? She grows the crop.

Now we look more closely at the steps in the *zeer* process. Are the steps **events** or are they really ? The writer may represent an event as a simple happening, as in "the water cools," or as an action, as in "the pot cools the water."

Student A often represents the steps as events. Student B often represents them as actions. Compare Students A and B below:

Student A (Events)	Student B (Actions)
"Water (goes) through the clay"	"special pots absorb the water;"
"The clay cools."	
"The pot cools."	"this evaporation cools the pots"
	"so the pots cool the
"The water cools."	water"

This difference is important. It relates to two very different patterns of cause: **event** causation (as in "the pot cools, so the water cools") and **agent** causation (as in "the pot cools the water"). The differences between representing a process as events or as event causation, and representing it as actions and agent causation are highly significant as we will see later.

Part IV: What is the vocabulary of cause?

In traditional language teaching *causal* language may be presented as a matter of a few items of grammar, like "because" and "so." *Causal meaning* , however, covers much wider ground. In fact, the vocabulary of cause (the "lexico-grammar" of cause) is very rich. We will discuss the vocabulary of event causation first and then discuss the vocabulary of agent causation. The general vocabulary pattern of event causation is CAUSE CAUSES EFFECT. The general

vocabulary pattern of agent causation is AGENT PRODUCES RESULTS from MATERIALS with MEANS for PURPOSES.

Halliday and Martin (1993:66) show how scientific English has evolved to express event causation in the use of vocabulary items ("causes," "the cause") as well as in the use of the more obvious grammar items ("so"). They state that the grammar of scientific English has been continuously evolving from

"A happens: so X happens"===> "happening A causes happening X"
Thus, a sentence like
"The stress becomes greater so the crack grows faster." ===>
"The magnitude of the applied stress ***causes*** crack growth." (or)
"The magnitude of the applied stress ***increases*** the rate of crack growth."
The verb may be *cause* or a variety of related words like *increase* . The zeer passage has a number of examples of verbs of cause:
"This pot **allows** water to be slowly absorbed"
" **making** it taste purer"
"no electric or gas refrigeration **is required** "

However, none of these appears in the students' recall texts. This suggests that the students are not very familiar with these verbs, or at least that these verbs are not in their productive vocabulary. However, academic textbooks contain a wide range of verbs of *cause* . For example, the short, half-page article on refrigeration in the 1995 *Encyclopedia Brittanica* has these verbs: *cause, control, create, develop, increase, inherit, initiate, permit, preserve, remove* . Related nouns include *cause, conditions, action, affect, result, increase* , and *change* . It is not difficult for students to become more aware of such words. Students can check these and similar items in a thesaurus like Kipfer (1993) and then search for them in actual texts.

Agent causation vocabulary is well illustrated in the encyclopedia article on "Refrigeration." A basic example of the agent pattern is:

Ancient peoples.cooled their food with ice.

The pattern shows up in a more elaborate form in the definition of *refrigeration*:

the process of removing heat from an enclosed space or from a substance for the purpose of lowering the temperature.

Notice how the more elaborate form draws on more elaborate and general vocabulary like *process, space, substance* , and *purpose* . In particular, elaboration of agent causation calls for the vocabulary of agents and means.

Agents. Everyone is familiar with examples of **agents** like *cooler, freezer,* or *refrigerator* , where the agentive suffix - has been added. Further examples of **agent** vocabulary can be found in the following:

The basic components of a modern vapour-compression refrigeration system are a compress ; a condens ; an expansion device, which can be a valve, a capillary tube, an engine, or a turbine; and an evaporat.

Means. Similarly, more elaborate talk about **means** calls for a vocabulary of **means**, often with subtle differences of meaning:

Stored ice was the principal of refrigeration until the beginning of the 20th century, and is still used in some areas.

Cooling caused by the rapid expansion of gases is the primary of refrigeration today.

The of evaporative cooling, as described heretofore, has been known for centuries, but the fundamental of mechanical refrigeration were only discovered in the middle of the 19th century.

Words like *means, technique, method,* and *manner* are very obvious, as are verbs like *used, utilized, employed* . Less obvious words occur in the article such as the following:

- *coolant* and *refrigerant* ("a substance used as a means to cool or refrigerate")

- *device*, *machine* , and *equipment* (which imply a mechanical means, instrument or contrivance)

There are two main points that need to be made about the vocabulary of cause. First, learners will need to be familiar with a wide range of cause vocabulary if they are to read academic discourse successfully. Second, the different shades of meaning of cause vocabulary are vital for causal thinking. There is a great deal of difference between making something happen and allowing something to happen, or between a method and a tool. Increased awareness of these differences is important both for thinking about causal ideas and expressing causal ideas.

Part V: Which Models of Cause-Effect: Regularity? Powers?

We now look more closely at the meaning of *cause-effect* . Within the Western European tradition of thought, there is no single, simple model of the *cause-effect* relation (see Footnote 1 below). Harre and Madden (1975) describe two models of *cause-effect* which are historically and currently of major importance in *causal* explanation. They call these two models "Regularity" and "Powers."

The **Regularity** view is a doubter's or critic's view. The regularity view assumes that the only thing that is real is the time sequence. The causal relation exists only in the mind of the speaker.

The **Powers** view is closer to everyday, common sense language use. A causes B by making B happen ("The pot cools the water.") Causes have the power to bring about their effects. The Regularity view does not allow actions, agents, and causal relations. The Powers view does.

The students seem to hold different models of *cause-effect*. It may be that Student A holds a Regularity view of cause. A's account of the zeer process mainly mentions events in time sequence and does not mention *causal* relations (see Footnote 2 below). Student B, on the other hand, may hold a Powers view, since B does mention actions and *causal* relations.

How we view *cause-effect* is important. Does smoking **cause** cancer? Studies show that smoking is often **followed by** cancer, but tobacco companies argue that statistical evidence like this is merely a correlation and does not **prove** that smoking **causes** cancer. They are objecting to the Regularity model.

Does teaching result in student learning? Does language teaching result in language learning? Some specialists argue that language cannot be taught. It can only be learned. Are they assuming a Regularity model? "The teacher taught the student" is an action. "The student learned" is an event. How we view these educational debates depends upon our models of *cause-effect*.

Part VI: Summary and Conclusion

Traditional approaches to FL/SL teaching generally take a somewhat limited, sentence-level view of *causal* discourse. Such approaches fail to help learners with the advanced grammar and vocabulary of causation, and, thus, fail to help them with the interpretation and expression of extended academic *causal* discourse. They do not deal adequately with meaning. They do not examine learners' models of *cause-effect* . Thus, learners do not get the help they need in gaining an education through academic discourse, and in using language as a medium of learning. An approach which understands the foreign/second language as a medium of learning provides a different view, and a much deeper vision of the processes of language as a medium of learning. It recognizes that *causal meanings* are expressed through the resources of a rich vocabulary and grammar. These resources are not available at age five or six, but are built up over years of education. They enable learners to understand and construct large structures of *causal* discourse. These resources need to be identified and developed in first and FL/SL language education.

This approach recognizes that *causal* discourse is a matter of meaning as well as form, and that the subtleties of *causal* meanings need to be brought to learners' awareness. It recognizes that *causal meanings* support the learners as they construct causal thought. It acknowledges that *causal meanings* are a common concern of, and a target for cooperative work by the language specialist and the subject matter specialist. Educational initiatives based on this approach are needed if we are to respond to the challenges posed by the role of the foreign/second language as a medium of learning.

Bernard Mohan is a professor of Language Education at the University of British Columbia, Vancouver, Canada. He has taught in Britain, the U.S. and Canada, and is specially interested in language as a medium of learning content and culture.

Margaret van Naerssen is currently at the University of Pennsylvania, Graduate School of

Education and English Language Programs, and in the Cultural and Linguistic Diversity Program, Immaculata College. She has worked in the EFL/ESL field for more than thirty years.

References

- Halfpenny, P. 1994. Causality. In The Blackwell dictionary of 20th century social thought. eds. Outhwaite, W. and T. Bottomore. Oxford: Blackwell.
- Halliday, M. A. K. and J. R. Martin. 1993. Writing science. London: The Falmer Press.
- Halliday, M. A. K. 1994. An introduction to functional grammar. 2nd ed. London: Edward Arnold.
- Harre, R. and E. H. Madden. 1975. Causal powers. Oxford: Blackwell.
- Kipfer, B. 1993. Roget's 21st century thesaurus. New York: Dell.
- Kress, G. 1994. Learning to write. 2nd ed. London: Routledge.
- Longacre, R. E. 1989. Two hypotheses regarding text generation and analysis. Discourse Processes, 12, pp. 413-460.
- ---.1990. Storyline concerns and word order typology in east and west Africa. Studies in African Linguistics. Supplement 10.
- Mohan, B. 1986. Language and content. Reading, MA: Addison-Wesley.
- van Naerssen, M. 1989. Encouraging student independence in solving problems in research report writing. Laie, Hawaii: Brigham Young University, TESL Reporter, 22, 3, pp. 52-53.
- van Naerssen, M. and M. Brennan. 1995. SciTech: Communicating in English about science and technology. Boston, MA: Heinle & Heinle.
- Veel, R. (forthcoming) Exploring literacy in school science, write it right: Resources for literacy series. Disadvantaged Schools Program, Metropolitan East, NSW Department of School Education, Sydney.

Figure 1

Reading about a Water Cooler

Traditional pottery in the dry climate of the Middle East includes a special pot for holding drinking water. This pot allows water to be slowly absorbed by the clay. As the absorbed water reaches the outer surface of the pot, it evaporates quickly because of the dry air. Because evaporating molecules absorb heat from their surroundings, evaporation functions as a cooling process. This process, in turn, cools the pot. The pot then cools the water held in the pot. Thus, we have an "air-powered" water cooler; no electric or gas refrigeration is required. People who use these pots also claim that the clay absorbs some of the impurities in the water, thus making it taste purer.

This type of pot has various shapes in different parts of the Middle East. The "zeer" (in Egypt) comes to a point at the bottom. Since it does not have a flat bottom, (see sketch) it is usually supported in a wooden or metal holder. The water that has seeped through the pot runs down the sides of the pot and drips off the pointed bottom. Archaeologists sometimes find a small hole in the ground or floor, made by the dripping water; this shows where a "zeer" had been kept for many years.

Figure 2

Student Example A

1. ***Put*** water in a clay pot.
2. Water through the clay and ***reaches*** the outer surface of the pot.
3. Water ***evaporates*** to the air around the pot.
4. ***Absorb*** the heat around the pot.
5. The clay ***cools***.
6. The pot ***cools***.
7. The water ***cools***.

Student Example B

First of all, special pots ***absorb*** the water;
After this, the water ***goes*** to the surface of the pots.

The water ***evaporates*** and this evaporation ***cools*** the pots *so* the pots cool the water and it is done.

Student Example C

If water ***is put*** into the clay pottery.
Water ***is absorb*** in the clay and duduntry (?) *that time* water can be purer, and water ***come out*** the surface of the pottery and water is easy to evaporate. *Because* of the dry climate.
When water ***evaporates*** it ***absorb*** the heat and the pottery.
So the pottery can keep the cooling water.
It is cooling process without electronic supply.

Figure 3

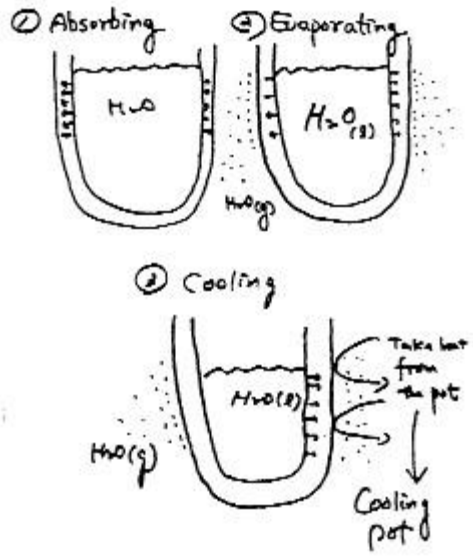


Figure 4

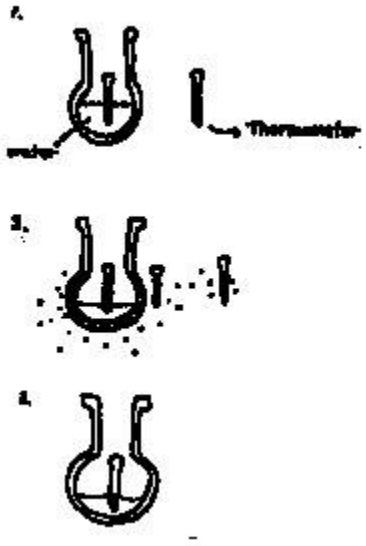
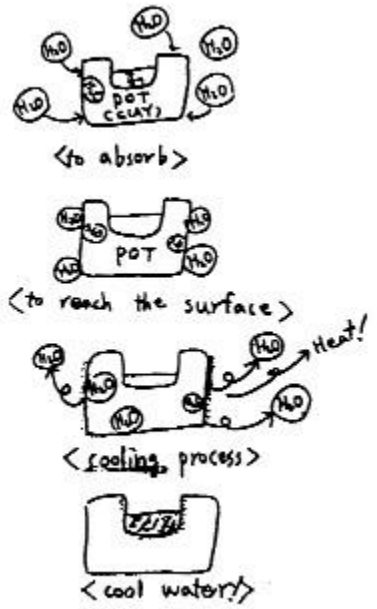


Figure 5



1. From SCITECH: Communicating in English about Science and Technology and Instructor's Manual by Margaret van Naerssen and Moya Brennan. Copyright 1995 by Heinle and Heinle Publishers, Inc. Reprinted with permission of Heinle and Heinle Publishers, Inc.

Footnote 1

2. It would be interesting to examine research on models of causality in non-Western European cultures.

Footnote 2

3. However, it is possible that Student A may also hold a Powers view and simply not have the linguistic skills to express the idea and falls back on a linguistically simpler model.